# AIR QUALITY SURVEY

# (TAGA 3000)

# DOMTAR WOOD PRESERVERS INC.

# TRENTON - JULY 1989

JANUARY 1990



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# (ARB-258-89)

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SOUTHEASTERN REGION

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## Executive Summary

At the request of the Southeastern Region, the mobile TAGA 3000 unit of the Ministry's Air Resources Branch conducted an air quality survey in Trenton on July 11, 12, 13, 17, 18, 19 and 20, 1989. The survey objective was to chemically "fingerprint" the odours associated with Domtar Wood Preservers Inc. (DWP) and to determine the ambient concentrations of phenols, chlorophenols and selected polycyclic aromatic hydrocarbons (PAHs) downwind of DWP.

The survey crew noted tar odours downwind of DWP on each monitoring day. The intensity of this odour ranged from mild to very strong. Analysis of the mass spectra of ambient air samples taken downwind of DWP provided evidence for the following contaminants: phenol, xylenes, cresols, $C_3$ and $C_4$-alkyl benzenes, dibutylamine and PAH groups namely, $C_{10}H_8$ (naphthalene), $C_{11}H_{10}$ (methylnaphthalene), $C_{12}H_{10}$ (biphenyl), $C_{12}H_{12}$ (ethylnaphthalene), $C_{13}H_{10}$ (fluorene), $C_{13}H_{12}$ (methylbiphenyl), $C_{13}H_{14}$ (trimethylnaphthalene), $C_{14}H_{10}$ (anthracene), $C_{14}H_{14}$ (dimethylbiphenyl) and $C_{14}H_{16}$ (diethylnaphthalene).

Low levels of phenol and cresol were detected; phenolic odours were not readily evident. Concentration estimates of phenol ranged from non-detected to 9 $\mu g/m^3$ and, of cresol from non-detected to 4 $\mu g/m^3$ which are well below the Ministry standards of 100 and 230 $\mu g/m^3$, respectively. Pentachlorophenol was also detected with half-hour average levels between 2 to 8 $\mu g/m^3$, well below the Ministry guideline of 60 $\mu g/m^3$.

Naphthalene was the most abundant contaminant recorded downwind of DWP. Half-hour average concentrations of naphthalene, in residential areas directly downwind of DWP, were in the range 2.7 to 130 $\mu g/m^3$. Twenty three, or approximately 58% of the 40 half-hour averages, indicated that naphthalene levels exceeded the Ministry guideline of 36 $\mu g/m^3$. Approximately one quarter of the readings showed naphthalene levels in the range of 70 to 130 $\mu g/m^3$ or more than two times the Ministry guideline. The Ministry guideline for naphthalene is based on health effects. Half-hour average concentration levels of the PAH groups $C_{11}H_{10}$, $C_{12}H_{10}$ and $C_{13}H_{10}$ (probably methylnaphthalene, biphenyl, fluorene) were in the range 1.5 to greater than 120 $\mu g/m^3$. Currently no Ministry standards or guidelines are available for these PAH compounds. It is recommended that the Southeastern Region consider the implementation of a detailed PAH monitoring programme in the vicinity of DWP to determine the impact of PAHs on the local air quality.

## Table of Contents

## List of Figures



## List of Tables

## 1.0 Introduction

At the request of the Southeastern Region of the Ontario Ministry of the Environment, the Air Resources Branch conducted a mobile air monitoring survey in the vicinity of Domtar Wood Preservers Inc. (DWP) in Trenton, Ontario, during July, 1989. The Southeastern Region expressed special interest in the levels of pentachlorophenol and PAHs downwind of DWP. In May 1987 the Air Resources Branch conducted a preliminary survey at DWP (Report ARB-146-87) to chemically characterize the odours: the major compounds identified at this time were naphthalene and phenol. The 1987 survey data was only semi-quantitative, thus the main objective of this survey was to provide quantitative information regarding contaminants downwind of DWP. As in the previous survey, the mobile TAGA 3000 mass spectrometer was used for this study.

The Domtar Wood Preservers Inc. is located between the Trent River and Marmora Street in the City of Trenton. There are two retorts used for treating wood: retort #1 for treating poles with pentachlorophenol (PCP) and retort #2 for treating ties with creosote. A 50/50 mixture of heavy oil and creosote is used to treat railway ties and a 95/5 mixture of light oil and pentachlorophenol (PCP) is used for preserving utility poles. The treating process involves impregnating the wood with the appropriate oil mixture for several hours under pressure in the retorts. Tar odours are mainly noticeable at times when the treated wood is removed for air-drying on-site in an open area. During the survey period retort #1 and retort #2 were opened at least once a day and treated wood was removed. A detailed description of DWP's wood preserving process is provided in Appendix C, along with the operating status and schedules of the pertinent processes during the survey period.

Presented here are the findings of the DWP air monitoring study as determined by the mobile TAGA 3000 unit on July 11, 12, 13, 17, 18, 19 and 20, 1989.

## 2.0 The TAGA "Fingerprinting" Technique

The Trace Atmospheric Gas Analyser (TAGA) model 3000 is a specialized single quadrupole mass spectrometer with a unique air sampling inlet system and ion source which operates at atmospheric pressure. Ambient air is sampled continuously at a high flow rate (100 l/min.) directly into the ionization chamber, where various classes of contaminants are selectively ionized through the addition of the appropriate chemical ionization (CI) reagents to the flowing air sample. For example, atmospheric water vapour highlights ketones, aldehydes, alcohols and acids; ammonia highlights amines, amides and some ethers; benzene highlights aromatics and sulphurous species, and oxygen highlights phenols, chlorophenols and acids.

The ionization of pollutants yields a mixture of pseudo-molecular ions which are immediately subjected to mass analysis up to 250 amu (atomic mass units). Mass "fingerprinting" is achieved in approximately 20 minutes if all four CI reagents are employed. The chemical, or pollutant, fingerprint arises from the interpretation of the mass spectra for a given monitoring period. Since the analysis of TAGA 3000 data is based on mass spectral interpretation, the resultant chemical identifications are somewhat tentative, the degree of uncertainty dependent on the complexity of the air sample. Occasionally, parallel samples are collected by means of solid sorbent tubes and contaminants are confirmed by GC/MS at our laboratory.

Owing to the system's unique feature of direct air sampling, and atmospheric chemical ionization, the technique is highly sensitive to many polar organic pollutants in real-time. In general, the TAGA can detect volatile compounds which contain a heteroatom such as N, O, P, S, or halide. Typical real-time detection limits for the TAGA are in the range of 0.1 to 10 $\mu g/m^3$, depending on the type of chemical(s) and the complexity of the sample matrix.

Real-time quantitation of PAHs is achieved using a unique ionization method in the APCI (Atmospheric Pressure Chemical Ionization) source of the TAGA systems. In the positive ion mode PAHs are detected as molecular ions via charge transfer reactions initiated by molecular benzene ions. For example, naphthalene is observed as $C_{10}H_8^+$. The TAGA 3000 provides information on individual PAH groups, not specific isomers. Calibration of the TAGA response to volatile PAHs is accomplished by injecting known amounts of PAHs directly into the air stream via a motorized syringe drive. For this particular survey, a benzene solution containing naphthalene, 2-methylnaphthalene, biphenyl and fluorene, was used for calibrating the TAGA response to the $C_{10}H_8$, $C_{11}H_{10}$, $C_{12}H_{10}$ and $C_{13}H_{10}$ PAH groups. Calibration curves were generated at least twice daily for naphthalene, methylnaphthalene, biphenyl and fluorene over the concentration range of 0 to 130, 0 to 120, 0 to 60 and 0 to 25 $\mu g/m^3$, respectively. Appendix A lists the daily average TAGA responses to four PAHs. Average detection limits for naphthalene,

methylnaphthalene, biphenyl and fluorene as determined during the survey were approximately 1, 0.4, 0.4 and 0.2 $\mu g/m^3$, respectively. Periodically the TAGA was also calibrated for pentachlorophenol. The detection limits for pentachlorophenol during the survey period were in the range 1 to 3 $\mu g/m^3$.

## 2.1 Survey Strategy

Basically, the survey strategy was to position the mobile TAGA unit downwind of DWP during an odour episode and acquire air quality data. For this particular survey it was desirable to take measurements prior to and during the opening of the DWP retort doors. Since one of the objectives of this survey was to chemically characterize any odours, mass spectral data were recorded at times when odours were persistent. Ideally odours must be present for at least 20 minutes, the time it takes to complete the fingerprinting process. Monitoring locations were selected using the following criteria:

1) wind direction and wind speed
2) plume tracking (real-time target compound measurements while mobile)
3) presence of odours
4) type of chemicals detected (fingerprint)
5) road network and accessibility.

Wind speed and wind direction data, collected at a height of 10 meters, were displayed by the on-board computer system and updated every 30 seconds. The meteorological data ensured that the monitoring locations were downwind of DWP.

Plume tracking refers to the real-time determination of the instantaneous concentrations of PAHs while the TAGA unit was driven in the vicinity of DWP. Provided the winds are steady and the PAH concentrations are above background levels, plume tracking can immediately reveal the highest ground level concentrations and the "best" monitoring locations.

In addition to downwind (source) monitoring, TAGA data were also acquired at locations upwind of DWP (background). The source data was then background-corrected by simply subtracting the upwind signals from the downwind signals for each amu (atomic mass unit). The net signal is attributed to the source, provided the winds are appropriate.

## 3.0 Results and Discussion

The mobile TAGA 3000 crew conducted ambient air monitoring in Trenton on July 11, 12, 13, 17, 18, 19 and 20, 1989. A total of 13 chemical fingerprints of the ambient air were determined at a number of locations downwind of Domtar Wood Preservers Inc. A majority of the monitoring was conducted near the DWP property along Marmora Street and on the W side of the Trent River along Water Street approximately 1/2 km from DWP (See Map 1). Table 1 summarizes the survey activities: downwind monitoring periods; sampling locations; local meteorological conditions; and relevant comments. The chemical fingerprints of the DWP odours are summarized in Table 2, and listings of the half-hour concentrations of four selected PAHs in Table 3.

Note that the concentrations quoted in Table 2 (odour fingerprints) are only estimates (within a factor of 5) since the sampling periods are only two minutes. Also, the compound identities are tentative for they are based on mass spectral interpretations. However, naphthalene, the major contaminant, was confirmed by other analytical techniques; namely, GC/MS and GC/MI/FTIR. The half-hour (average) concentration data are based upon calibrated response factors (Appendix A). The concentrations listed for the PAH groups refer to the sum of the concentrations due to different isomers involved. Isomers of dicyclic and tricyclic aromatic hydrocarbons, along with some physical characteristics, are listed in Appendix B.

### July 11

This was a sunny, warm day with NNW winds ranging in speed from 5 to 30 km/hr. Plume tracking was conducted for selected PAHs downwind of DWP. Odours were detected along the gravel railway access road S of the DWP property. Two fingerprints (01 and 02, Table 2) were obtained on the gravel road, approximately 75 metres W of Marmora Street (Site A) from 9:26 to 10:22 hours. Analysis of these fingerprints indicated the presence of dibutylamine, three alkyl benzene groups and ten PAH groups in an estimated concentration range of 1 to 10 $\mu g/m^3$ for a two minute average. The TAGA was then moved to the end of Chester Street for collection of upwind data. Calibrations were performed for PAHs, phenol, p-chlorophenol and pentachlorophenol (PCP).

At 14:00 hours, plume tracking commenced and odours were detected downwind of DWP in the Trenton Police Station parking lot S of Dixon Drive (Site B). A half-hour average of four selected PAHs was initiated at 14:20 hours (S01, Table 3). Winds were from the NW at 20 to 30 km/hr and occasionally odours from Domtar's paper mill were detected. The half-hour average ambient concentration of naphthalene was 14 $\mu g/m^3$; below the Ministry guideline of 36 $\mu g/m^3$.

Two consecutive half-hour averages of PCP were also collected at Site B. The first half-hour period began at 15:08 and the second began at 15:42. While monitoring, observations were made of the activities at DWP by a member of the survey crew. During the second half-hour monitoring period, the door of the PCP retort was opened. At 15:52 the removal of the treated poles began, with light steam visible. A slight increase in the instantaneous level of PCP was noted at 15:53. The half-hour average concentration of PCP for the two monitoring periods was 4.1 and 4.5 $\mu g/m^3$ respectively. These levels are well below the Ministry guideline of 60 $\mu g/m^3$.

At 16:20 hours a half-hour average of PAHs was acquired (S02, Table 3). During this monitoring period winds began shifting between N and NW. The half-hour average concentration of naphthalene was 13 $\mu g/m^3$. Due to shifting winds, the TAGA moved back to the gravel railway access road (Site A) where a half-hour average of PAHs was obtained (S03, Table 3) commencing at 18:01 hours. At 18:16 hours the door of retort #2 (creosote) was opened, followed by removal of the treated ties. During this period the winds were variable, resulting in an intermittent odour. The half-hour average concentration of naphthalene was 16 $\mu g/m^3$. A fingerprint of the odour was initiated at 18:33 hours (03, Table 2). This revealed the presence of phenol, dibutylamine, alkyl benzenes and 10 PAH groups with estimated concentrations in the range of 1 to 11 $\mu g/m^3$ for a two minute sampling period. The TAGA was then moved to Pacific Street, 50m E of Leopold Street for collection of upwind data and calibration of PAHs at 19:00 hours.

**July 12**

The survey day began with the calibration of PCP and the collection of upwind data at 15:30 hours on Meyers Street, 10m E of Ontario Street. At 16:36 plume tracking was conducted for PAHs in the neighbourhood E of DWP. Odours were detected primarily in the area bounded by Hannah, Marmora, Peter and West Streets. At 17:14 hours a half-hour average of PAHs (S04, Table 3) was acquired on Mary Street, 10 metres E of Marmora Street (Site C) where the odour was perceived to be strongest. At 17:31 it was observed by a survey crew member that the door of retort #1 was open and treated poles were being removed. The half-hour average concentration of naphthalene was 26 $\mu g/m^3$.

Following the half-hour average, a chemical fingerprint of the odour was taken (04, Table 2) at Site C. Dibutylamine, alkyl benzenes and several PAH groups were detected. The estimated concentrations were up to 30 $\mu g/m^3$ for a 2 minute average. A half-hour monitoring of PCP conducted from 18:11 to 18:41 hours indicated an average PCP level (1.5 $\mu g/m^3$) which was slightly above the detection limit. Once again a half-hour average of PAHs was obtained (S05, Table 3), commencing at 18:48 hours. The average concentration of naphthalene was 36 $\mu g/m^3$, equivalent to the Ministry guideline.

After calibrating for PAHs, the TAGA was then moved to Marmora Street, 5 metres S of Mary Street where the odour was present (Site D). Three half-hour averages of PAHs were collected (S06, S07 and S08, Table 3) with start times of 20:27, 20:59 and 21:29 hours respectively. Strong odours were present, resulting in half-hour average concentrations of 69 $\mu g/m^3$, 95 $\mu g/m^3$ and 78 $\mu g/m^3$ respectively for naphthalene. All three readings were above the Ministry guideline for naphthalene (36 $\mu g/m^3$).

At 22:02 hours a fingerprint of the odour was taken at Site D (05, Table 2). Analysis revealed the presence of phenol, methyl phenol, dibutylamine, alkyl benzenes and 8 PAH groups in an estimated average concentration range of 1 to 20 $\mu g/m^3$ for a 2 minute sampling period. Following the fingerprint, a half-hour average of PAHs was collected, beginning at 22:17 hours (S09, Table 3). At 22:23 hours a survey crew member reported that the door to retort #2 was opened. The treated wood was removed at 22:27 hours and fresh wood was put in the retort at 22:37 hours. The calibrated half-hour average concentration of naphthalene during this period was 108 $\mu g/m^3$, well above the Ministry guideline.

A half-hour average of PAHs was collected at Site D starting at 22:49 hours (S10, Table 3). The estimated half-hour average concentration of naphthalene was 69 $\mu g/m^3$. At 23:21 hours another fingerprint was acquired (06, Table 2) and analysis revealed the presence of phenol, methyl phenol, dimethyl phenol, 3 alkyl benzene groups and 10 PAH groups. Estimates of the 2 minute average concentrations ranged from 2 to 90 $\mu g/m^3$. The TAGA was then moved at 23:40 hours to the Trent Region Conservation Authority parking lot on Water Street for the collection of upwind data and calibration of PAHs.

**July 13**

The survey day began at 12:30 hours with plume tracking for PAHs downwind of DWP. Due to variable winds and lack of detectable odour, monitoring was halted until 16:40 hours, when the winds were steady from the N to NW. Upwind data was collected and calibrations of PAHs and PCP were conducted at the Trent Region Conservation Authority parking lot on Water Street.

Plume tracking was performed at 18:00 hours to establish a downwind monitoring location: the gravel railway access road approximately 300 metres W of Marmora Street (Site E). Three half-hour averages of PAHs (S11, S12 and S13, Table 3) were collected starting at 19:15, 19:49 and 20:30 hours respectively. The mild odour detected during this period was different than the tar odour detected earlier. In each of the three half-hour averages, the average concentration of methylnaphthalene was higher than naphthalene (see Table 3). Analysis of a fingerprint of the odour conducted at 21:20 hours (07, Table

2) revealed the presence of dibutylamine, alkyl benzenes and 8 PAH groups with an estimated concentration range of 1 to 25 $\mu g/m^3$ for a 2 minute average.

Two more half-hour averages of PAHs were collected at Site E starting at 21:31 and 22:19 hours (S14 and S15, Table 3). During the first half-hour monitoring period the wind shifted to the NNW, resulting in a naphthalene concentration (31 $\mu g/m^3$) greater than that of methylnaphthalene. During the second half-hour period, the wind shifted back to the NNE, and once again the methylnaphthalene levels (23 $\mu g/m^3$) exceeded those of naphthalene (9.0 $\mu g/m^3$).

At 23:00 hours, with winds out of the NNE, plume tracking was conducted on the W side of the Trent River. A downwind site was established at the corner of Bentinck and Water Streets (Site F). A half-hour average of PAHs was determined at 23:09 hours (S16, Table 3). Odour was moderate and the wind speed was low (0 to 5 km/hr). At 23:29 a survey crew member observed the removal of treated poles from retort #1. The estimated half-hour average concentration of naphthalene was 32 $\mu g/m^3$. Plume tracking was then conducted for PCP, but it was not detected. At 00:17 hours upwind data was collected and calibration of PAHs was performed at the corner of Leopold and Pacific Streets.

**July 17**

This was a sunny day with moderate winds from the N to NW. Upwind monitoring and calibrations for PCP were performed at the end of Chester Street, 50 meters from the Trent River dam. A half-hour average (S17, Table 3) of PAH levels was recorded at the intersection of Mary Street and Marmora Street (Site C). The half-hour average concentration of naphthalene was 51 $\mu g/m^3$. With moderate to strong tar odours being present and emissions from one of DWP's cylinders still visible, a fingerprint (08, Table 2) was recorded. Ten PAH groups were identified. The most abundant contaminant was naphthalene estimated at 110 $\mu g/m^3$ for a 2 minute average and 1 to 40 $\mu g/m^3$ for the other PAH groups. Two more half–hour averages (S18 and S19, Table 3) recorded at this site (C) indicated average naphthalene levels of 63 and 67 $\mu g/m^3$, almost twice the Ministry guideline of 36 $\mu g/m^3$.

Plume tracking revealed that elevated levels of PAHs were present in the residential area enclosed by the streets Marmora, Leopold, Hannah and Peter. A "sweet" type odour was noted near Peter and Marmora about 50 meters from a pile of previously treated utility poles (Site G). In the presence of such odour, the concentration of methylnaphthalene was observed to increase, occasionally reaching levels comparable to or higher than those of naphthalene. This phenomenon is exemplified by the results of the half–hour average (S20, Table 3) measured when the sweet odour was persistent; the

average level of methylnaphthalene at 47 $\mu g/m^3$ was three times higher than that of naphthalene. Note that methylnaphthalene has an odour threshold of only 20 $\mu g/m^3$. Knowing that poles were treated with PCP, a half-hour average concentration of pentachlorophenol was recorded (10 $\mu g/m^3$) which is one-sixth the Ministry guideline of 60 $\mu g/m^3$. .

At 17:23 hours the mobile TAGA was moved to the parking lot of the Lower Trent Region Conservation Authority for upwind monitoring and calibrations for PCP and PAHs. A member of the survey crew observed that retort #2 was loaded with fresh wood at 18:17 hours. Although both retorts were closed strong tar and naphthalene–like odours were present on Marmora Street near Mary Street. According to Domtar personnel retort #1 was to open between 20:00 to 21:00 hours. Presumably the odours detected were due to the release of creosote vapours by lowering the pressure inside retort #1. Four half–hour averages (S21, S22, S23 and S24, Table 3) were recorded between 19:15 to 21:44 hours at Site C. The first three averages indicated that naphthalene levels were more than two times over the Ministry guideline.

**July 18**

This was a hot, hazy and humid day. Background levels were established in the parking lot of the Lower Trent Region Conservation Authority near Water Street. The TAGA was calibrated for pentachlorophenol and for four PAHs. Plume tracking revealed the presence of PAHs and strong tar odours along Marmora Street at 16:00 hours where the level of PAHs was highest. Two half-hour averages (S25 and S26, Table 3) were recorded at Site C. Both showed half-hour average concentrations of 58 $\mu g/m^3$ for naphthalene, 60% above the Ministry guideline. The maximum instantaneous concentration for naphthalene was slightly over 130 $\mu g/m^3$ during the one hour time period.

Naphthalene was tracked from Marmora Street for several hundred meters into the residential area E of DWP. The instantaneous concentrations of naphthalene recorded between 17:20 and 17:55 hours are plotted in a map of the area (Map 2). It is noteworthy that the naphthalene concentration was 30 to 70 $\mu g/m^3$ in the area enclosed by the streets: Hannah, Louis, West and Marmora. However, naphthalene levels recorded between West Street and Sidney Street were below 20 $\mu g/m^3$. During the survey, when westerly winds were prevalent, plume tracking in this area was performed several times and the concentration gradients of naphthalene were similar to the patterns shown in Map 2. A fingerprint (09, Table 2) was recorded at 18:01 hours on Marmora Street about 20 meters N of Peter Street (Site G). Piles of treated poles were located approximately 50 meters from the TAGA and a sweet odour of moderate intensity was noted.

At 18:13 hours the door of creosote retort #2 was opened and treated railway ties were removed. Emissions coming off the ties were visible and strong tar odours were noticeable along Marmora Street. The TAGA was moved to 177 Marmora Street, approximately half way between Mary Street and Hannah Street. The PCP retort #1 was opened at 18:53 hours, treated poles were removed and a considerable amount of steam was visible. A slight change in the characteristic of odour was noticed; tar odours were still persistent but a mild, sweet type of odour was also noticeable. Pentachlorophenol was detected at trace levels (3 $\mu g/m^3$). Three half-hour averages (S27, S28 and S29, Table 3) of PAH levels and a fingerprint (10, Table 2)were recorded at site H in the time period 19:05 - 20:44 hours. The first, commencing at 19:05 hours, showed a half-hour average concentration of 96 $\mu g/m^3$ for naphthalene and 82 $\mu g/m^3$ for methylnaphthalene. The last two half-hour averages indicated that naphthalene levels were greater than 130 $\mu g/m^3$. In fact, the levels of all four PAH groups which were monitored, were elevated considerably with increasing odour intensity. The fingerprint (10, Table 2) contained alkyl benzenes and ten PAH groups with naphthalene and methylnaphthalene being the most abundant. Comparing fingerprints 09 and 10 (Table 2) taken before and after the retorts were opened, it is clear that PAH levels were considerably higher when the retorts opened and freshly treated poles and ties were removed. For example, levels of naphthalene, methylnaphthalene and biphenyl were on average 10 times higher when the retort was opened and fresh treated wood was removed.

**July 19**

Cartridge samples for GC/MS and GC/MI/FTIR analysis were collected on July 19 to confirm the naphthalene levels since the TAGA data had thus far indicated several episodes in which the Ministry guideline was exceeded. The cartridge, containing solid adsorbents (Spherocarb, Carbotrap B and Carbotrap C), was mounted within 10 centimetres of the TAGA sample inlet. The 3 litre air samples were obtained using a portable Gilian Pump at a sampling rate of 100 ml/min. for 30 minutes.

The survey day began with the collection of upwind data and the calibration of PAHs from 12:15 to 13:30 hours on Pacific Street near Leopold Street. A half-hour cartridge sample of upwind ambient air was simultaneously collected with the TAGA upwind data. At 13:30 plume tracking commenced along the W side of the Trent River in order to locate the odour downwind of DWP. A downwind monitoring location was established on Water Street near Alberta Street (Site I). A survey crew member reported that at 13:31 the door of retort #2 was opened and the treated ties were removed. A half-hour average of PAHs was started at 13:57 hours (S30, Table 3). At the same time a cartridge sample was acquired in the same manner as described above. However, during this half-hour monitoring period the wind shifted from the E to the SW. This

resulted in a half-hour average concentration of naphthalene of 2.7 $\mu g/m^3$, comparable to background levels.

The TAGA was then moved to a downwind site on Marmora Street, approximately 30 m S of Hannah Street (Site J). Two consecutive half-hour averages of PAHs were collected (S31 and S32, Table 3) starting at 14:53. Two cartridge samples, one for GC/MS analysis and one for GC/MI/FTIR analysis, were collected simultaneously with each of the two TAGA 3000 half-hour averages. The half-hour average concentrations of naphthalene were 50 $\mu g/m^3$ and 67$\mu g/m^3$, as determined by the TAGA.

Two more half-hour averages of PAHs were collected at Site J (S33 and S34, Table 3) with start times of 16:06 and 16:38 hours respectively. One cartridge sample for GC/MS analysis was collected simultaneously with the second TAGA half-hour monitoring period. The half-hour average concentrations of naphthalene were 47 $\mu g/m^3$ and 65 $\mu g/m^3$ respectively as determined by the TAGA. At 17:10 the TAGA was then moved to Meyers Street near Ontario Street to collect upwind data and calibrate PAHs.

The TAGA returned to Site J where a half-hour average of PAHs, starting at 18:23 hours, was collected downwind of DWP (S35, Table 3). The odour was moderate to strong during this period, but the wind direction began to change from SW to NE. The half-hour average concentration of naphthalene was 81 $\mu g/m^3$.

Because of the wind direction change, plume tracking was conducted on the W side of the Trent River. A downwind site was established on Water Street 10m S of Bond Head Street (Site K). Two half-hour averages of PAHs were collected (S36 and S37, Table 3) starting at 20:26 and 20:56 hours respectively. At 21:04 hours, during the second half-hour of data collection, the door of Retort 1 was opened and treated poles were removed. The half-hour average concentrations of naphthalene were 18 $\mu g/m^3$ and 17 $\mu g/m^3$ respectively.

A fingerprint was also acquired at Site K, commencing at 21:28 hours (11, Table 2). Analysis of the fingerprint revealed the presence of phenol, alkyl benzenes and 5 PAH groups with an estimated concentration range of 1 to 8 $\mu g/m^3$ for a 2 minute monitoring period. Note that monitoring Site K was roughly 500 metres from the retorts.

The cartridge samples were then taken to the Air Resources Branch in Toronto and analysed in the lab the following day. A quantitative analysis was performed on 4 downwind cartridge samples using thermal desorption GC/MS. A comparison of the half-hour averages collected using the TAGA 3000 real-time monitoring and the cartridge samples analysed by GC/MS are presented in Table 4. A qualitative analysis was also performed by thermal desorption GC/MI/FTIR. This technique confirmed the presence of naphthalene and methylnaphthalene. As shown in Table 4, the two techniques, TAGA

and GC/MS gave very similar naphthalene concentration values. Given the fundamental differences in the two analysis techniques, the comparability of the results is excellent.

**July 20**

The weather conditions were generally overcast with winds from the NE at 5 to 20 km/hr. Upwind data were collected and calibrations of PAHs were performed in the parking lot of Queen Elizabeth Public School near Kitchener Street at 15:15 hours. At 16:20 hours a downwind site was established on Alberta Street 10 metres W of Water Street (Site L). Two half-hour averages of PAHs were collected (S38 and S39, Table 3) commencing at 16:26 and 16:57 respectively. At 16:40 the door of retort #2 opened and treated ties were removed. The half-hour averaged concentrations of naphthalene were 51 $\mu g/m^3$ and 16 $\mu g/m^3$. A fingerprint of the odour was acquired at 17:29 hours (12, Table 2). The odours had diminished to mild and intermittent at the time of fingerprint acquisition. Analysis revealed just traces (less than 2 $\mu g/m^3$) of dibutylamine, alkyl benzenes and 3 PAH groups.

At 17:53 hours a crew member reported that the door of retort #1 was opened and treated poles were being removed. A half-hour average of PAHs was started at 17:55 hours (S40, Table 3). The odour was mild to moderate following removal of the treated poles. The half-hour average concentration of naphthalene was 23 $\mu g/m^3$. Another fingerprint was obtained at 18:30 hours (13, Table 2) which indicated the presence of alkyl benzenes and several PAHs at concentrations estimated at 1 to 6 $\mu g/m^3$ for a 2 minute average.

At 18:50 hours the TAGA was moved back to the Queen Elizabeth Public School parking lot where another calibration of PAHs was performed and upwind data collected.

## 4.0 Summary and Conclusions

The mobile TAGA 3000 unit conducted an air monitoring survey in Trenton, Ontario on July 11, 12, 13, 17, 18, 19 and 20 at the request of the Ministry's Southeastern Region. The purpose of this survey was to chemically fingerprint the odours associated with Domtar Wood Preservers Inc. (DWP) and to determine ambient levels of pentachlorophenol and PAHs downwind of this plant. The findings of this survey are summarized by the following points:

1) Tar-type odours were recognizable downwind of DWP. The odours were generally strongest near the plant property along Marmora Street. The odours were moderate to strong at times in residential areas E of DWP or W of the Trent River. The monitoring data indicated that the strong odour episodes were associated with the operation of the retorts. Such odour episodes coincided with enhancement of the four PAH groups ($C_{10}H_8$, $C_{11}H_{10}$, $C_{12}H_{10}$, $C_{13}H_{10}$) as recorded downwind of DWP by the mobile TAGA 3000. A "sweet" odour was noted downwind of poles previously treated with PCP or when retort #1 was opened. The intensity of this type of odour was correlated with increases in the levels of $C_{11}H_{10}$ (methylnaphthalene) and to a lesser extent pentachlorophenol. A few of the compounds which were detected (eg. methyl phenol, methylnaphthalene) have low odour thresholds, which may have contributed to the odour present in the vicinity of DWP.

2) Mass spectral analysis of the odours (fingerprints) downwind of DWP indicated the presence of phenol, alkyl-benzenes, dibutylamine, and volatile PAHs. Naphthalene, methylnaphthalene, biphenyl, ethylnaphthalene, fluorene, methylbiphenyl, trimethylnaphthalene, anthracene dimethylbiphenyl and diethylnaphthalene are isomers which may have contributed to the ambient levels of the PAH groups detected. Estimated concentrations based on fingerprint data (See Table 2) ranged from non-detected to 110 $\mu g/m^3$ for 2 minute monitoring periods.

3) Half-hour averages of pentachlorophenol, measured when the PCP retort #1 was opened and treated wood was removed, indicated levels in the range 2 to 8 $\mu g/m^3$.

4) The most abundant contaminant was naphthalene which was identified by three independent analytical techniques: APCI/MS (TAGA), GC/MS and GC/MI/FTIR. Quantitative half-hour averages (See Table 3) indicated that its concentration ranged from 2.7 to greater than 130 $\mu g/m^3$. The Ministry guideline, which is based on health effects, is currently set at 36 $\mu g/m^3$ for a half-hour average concentration. The TAGA can only detect volatile compounds; other PAHs may also be present in the ambient air in the form of particulates or aerosols. The Ministry of the Environment has no guidelines or standards for PAHs other than naphthalene.

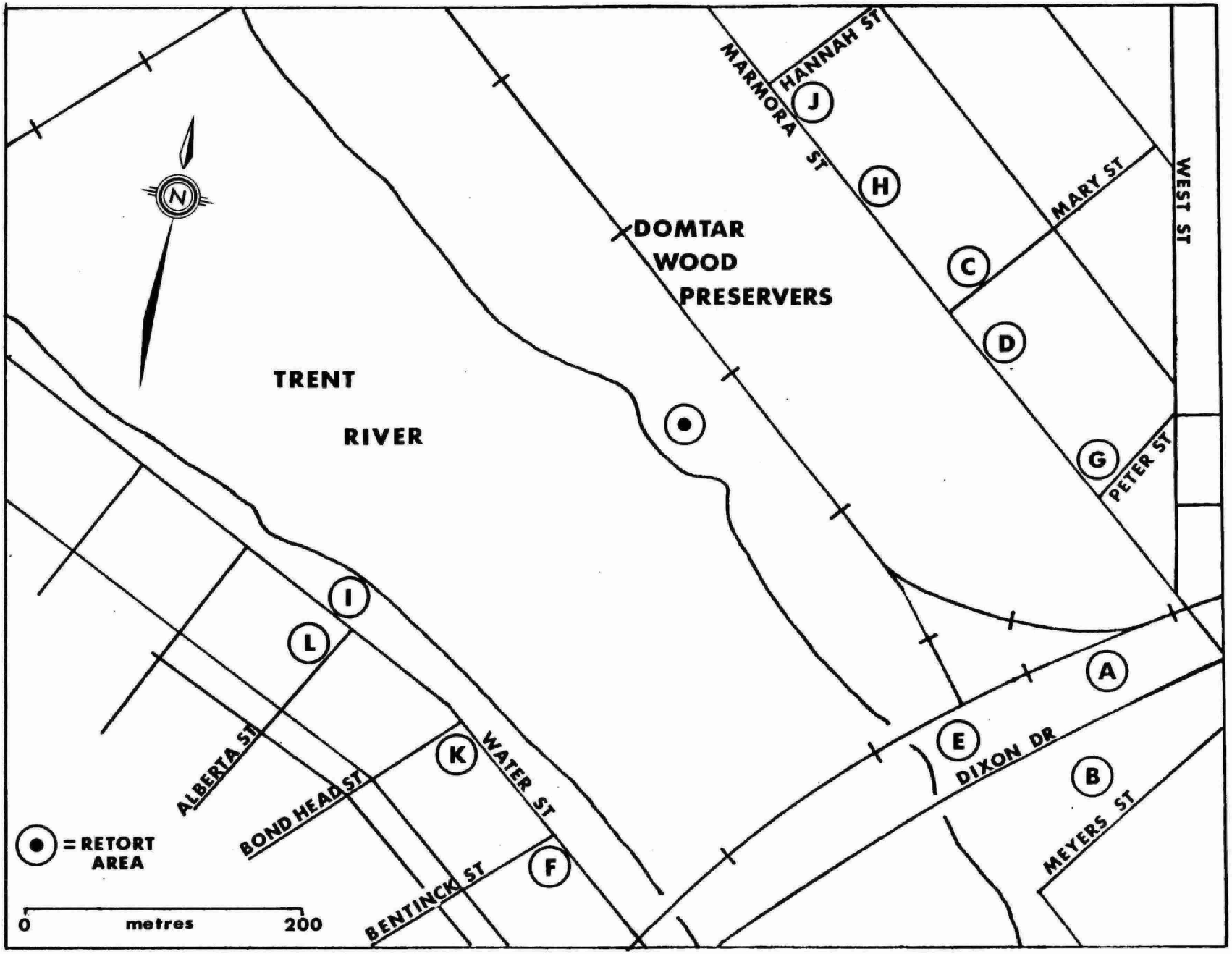
5) Although phenolic odours were not evident, possibly because tar odours were masking them, phenol and cresol were detected. Estimates of the maximum concentrations, based on 2 minute averages, were 9 $\mu g/m^3$ (phenol) and 4 $\mu g/m^3$ (cresol) which are well below the Ministry standards of 100 and 230 $\mu g/m^3$, respectively.

In conclusion, the survey results indicate that volatile PAH compounds (two and three member rings) and, to a lesser extent, phenols and cresols are partially responsible for the wood preserving odours observed downwind of DWP. It is important to note that these pollutants were detected near the plant property as well as in residential areas E and W of DWP, up to 500 metres from the plant. The survey crew found the odours strongest prior to and during the opening of the retort and removal of the charge. It should be mentioned that of the contaminants detected in the residential areas, only naphthalene was present in levels comparable to existing Ministry guidelines or standards. The highest half-hour ambient level of naphthalene was at least 130 $\mu g/m^3$, whereas the Ministry guideline for naphthalene is 36 $\mu g/m^3$. Of the 40 half-hour average concentrations of naphthalene, 23 or approximately 58% exceeded the Ministry guideline. Note that the guideline for naphthalene is based on health effects. It is suggested that the Southeastern Region consider the implementation of a detailed PAH monitoring programme in the vicinity of DWP to determine the impact of PAHs, both volatile and non-volatile fractions, on the local air quality.

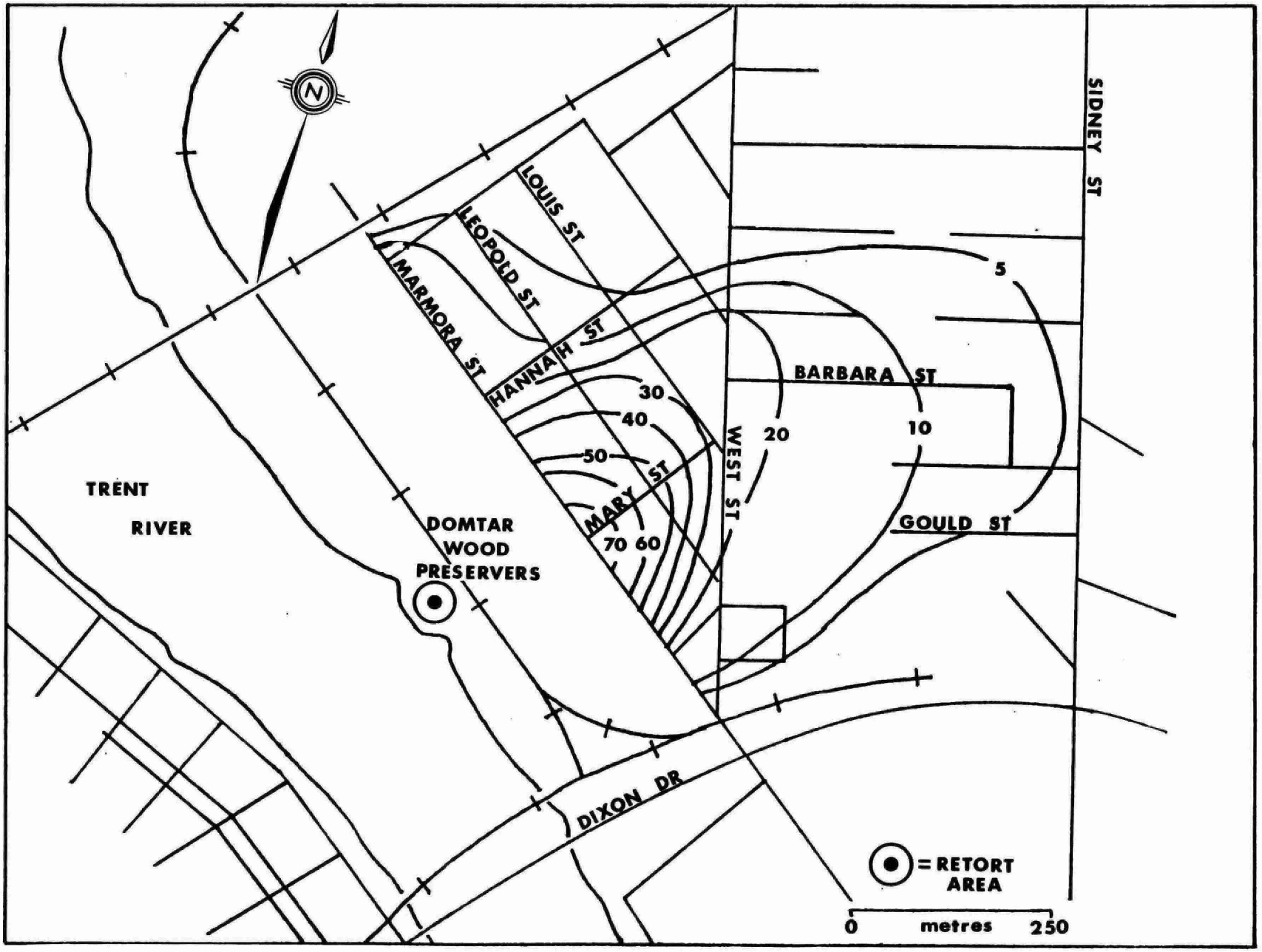
## 5.0 Acknowledgements

The author gratefully acknowledges the contribution of Mr. Cecil Burns of the Southeastern Region. Thanks is also extended to Mike Sage of the Air Resources Branch for the GC/MS analysis of cartridge samples, and to the TAGA 3000 survey crew:

Nicholas S. Karellas (SCIEX Consultant)
Robert J. Tooley (SCIEX Consultant)
John V. Merritt (SCIEX Consultant)




**Map 1:** Monitoring Locations Downwind of Domtar Wood Preservers Inc., Trenton




**Map 2:** TAGA 3000 Isopleth Map of Naphthalene From Domtar Wood Preservers Inc., July 18, 1989 17:20 - 17:55 Hours (Naphthalene Isopleth Concentrations in $\mu g/m^3$)

**Table 1:** Mobile TAGA 3000 Monitoring Periods and Locations of Odour Fingerprints
Trenton (Domtar Wood Preservers) Survey 1989

| Date | Fingerprint Number | Monitoring Period | Location[1] | Meteorological Conditions[2] AT | WS | WD | Comments |
|---|---|---|---|---|---|---|---|
| Jul 11 | 01 | 09:26-09:52 | A | 25 | 05-20 | NW | Moderate tar/phenol odour present |
| | 02 | 10:11-10:22 | A | 26 | 10-20 | NW | Moderate odour present |
| | 03 | 18:33-18:39 | A | 26 | 15-20 | N | Intermittent tar odour, winds variable |
| Jul 12 | 04 | 17:45-18:03 | C | 24 | 05-15 | SW | Moderate tar odour |
| | 05 | 22:02-22:13 | D | 18 | 00-05 | SW | Mild to moderate odour, low wind speeds |
| | 06 | 23:21-23:25 | D | 19 | 00-05 | SW | Odour present |
| Jul 13 | 07 | 21:10-21:36 | E | 21 | 00-05 | N/NNW | Constant mild odour |
| Jul 17 | 08 | 20:20-20:41 | C | 22 | 00-10 | SW | Moderate to strong tar odour |
| Jul 18 | 09 | 18:01-18:21 | G | 26 | 05-15 | S | Odour present (DW of PCP treated poles) |
| | 10 | 20:40-20:44 | H | 23 | 00-05 | SW | Strong odour present |
| Jul 19 | 11 | 21:28-21:39 | K | 23 | 00-05 | NE | Mild odour present |
| Jul 20 | 12 | 17:29-17:47 | L | 25 | 10-20 | NE | Constant mild odour |
| | 13 | 18:30-18:34 | L | 25 | 05-15 | NE | Mild odour present |

Notes:
1. See Map 1 for sampling locations.
2. Met. conditions at 10 metres: AT=ambient temperature (°C); WS=range of wind speeds (km/hr); WD=predominant wind direction

**Table 2:** Mobile TAGA 3000 Odour "Fingerprints"

Target Source: Domtar Wood Preservers
Trenton Survey 1989

| Compounds Detected[1] / Fingerprint[2] #= | Estimated Concentrations[3] ($\mu g/m^3$) 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | Ministry Criteria | Odour Threshold |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| phenol | ND | ND | 7 | ND | 9 | 7 | ND | ND | ND | ND | 5 | ND | ND | 100 (s) | 22[b] |
| methyl phenol | ND | ND | ND | ND | 2 | 4 | ND | ND | ND | 2 | ND | ND | ND | 230 (s) | 4.4[b] |
| dimethyl phenol | ND | ND | ND | ND | ND | 2 | ND | ND | ND | 1 | ND | ND | ND | n/a | 1.0[b] |
| dibutylamine | 1 | ND | 1 | 2 | 4 | ND | 2 | ND | ND | ND | ND | 1 | ND | n/a | 1,400[b] |
| $C_8H_{10}$ (eg. xylenes) | 2 | 3 | 2 | 1 | 10 | 3 | 6 | ND | 2 | 1 | ND | 1 | 4 | 2,300 (s) | 3,600[a] |
| $C_9H_{12}$ (eg. propyl benzene) | 2 | 3 | 2 | 1 | 15 | 6 | 9 | ND | 4 | 3 | 2 | 2 | 3 | n/a | n/a |
| $C_{10}H_{14}$ (eg. butyl benzene) | 2 | 3 | 1 | 3 | 6 | 9 | 5 | 3 | 3 | 6 | 2 | 1 | 2 | n/a | n/a |
| PAHs[6]: | | | | | | | | | | | | | | | |
| $C_{10}H_8$ (eg. naphthalene) | 9 | 9 | 11 | 30 | 20 | 90 | 25 | 110 | 2 | 70 | 8 | 2 | 6 | 36 (pg) | 450[a] |
| $C_{11}H_{10}$ (eg. methylnaphthalene) | 6 | 8 | 5 | 8 | 6 | 50 | 7 | 40 | 11 | 50 | 4 | 1 | 2 | n/a | 20[b] |
| $C_{12}H_{10}$ (eg. biphenyl) | 1 | 2 | 2 | 4 | 3 | 20 | 2 | 20 | 1 | 25 | ND | ND | 1 | n/a | 60[b] |
| $C_{12}H_{12}$ (eg. ethylnaphthalene) | 5 | 10 | 3 | 4 | 2 | 25 | 4 | 15 | 15 | 25 | 3 | 1 | 2 | n/a | 250[b] |
| $C_{13}H_{10}$ (eg. fluorene) | 1 | 1 | 1 | 1 | 1 | 5 | 1 | 6 | 1 | 7 | ND | ND | ND | n/a | n/a |
| $C_{13}H_{12}$ (eg. methylbiphenyl) | 1 | 2 | 1 | 2 | 2 | 6 | 1 | 7 | 2 | 9 | ND | ND | ND | n/a | n/a |
| $C_{13}H_{14}$ (eg. trimethylnaphthalene) | 3 | 5 | 1 | 1 | 1 | 8 | 1 | 5 | 7 | 8 | 1 | ND | 1 | n/a | n/a |
| $C_{14}H_{10}$ (eg. anthracene) | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 5 | ND | 5 | ND | ND | ND | n/a | n/a |
| $C_{14}H_{14}$ (eg. dimethylbiphenyl) | ND | 1 | ND | ND | ND | 2 | ND | 1 | 1 | 2 | 1 | ND | ND | n/a | n/a |
| $C_{14}H_{16}$ (eg. diethylnaphthalene) | ND | 1 | ND | 1 | ND | 2 | ND | 2 | 2 | 2 | ND | ND | ND | n/a | n/a |

Notes:
1. Tentative identities based on interpretation of APCI/MS mass spectral data. Numbers in parentheses indicate ion mass in atomic mass units (amu)
2. See Table 1 for sampling locations and monitoring periods
3. Two-minute averaged concentrations (estimated ±5x). ND = not detected
4. $C_2$-alkyl benzenes: mixture of xylene and ethyl benzene. Odour threshold value refers to mixed xylenes
5. $C_3$-alkyl benzenes: mixture of propyl benzene, ethyl toluene and trimethyl benzene
6. See Appendix B for a list of isobaric and isomeric PAH compounds including some of their physical properties
7. In $\mu g/m^3$, (s) = O.R. 308 Standard; (pg) = Provincial Guideline
8. In $\mu g/m^3$, population perception threshold

a. Procedure for the determination of odour impact models by the binary port odour panel method. Ontario Ministry of the Environment, Report # AMP-143 (Feb '89), Draft # 10
b. Gemert van, L.J., Central Institute for Nutrition and Food Research TNO), Netenbreizer, A.H., (National Institute for Water Supply), Compilation of odour threshold values in air and water, Netherlands, 1977

**Table 3:** Mobile TAGA 3000 PAH Concentrations (1/2 Hour Ave.)

Trenton (Domtar Wood Preservers) Survey 1989

| Date | Sample Number | Start Time | Location[1] | Meteorological Conditions[2] AT | WS | WD | 1/2 Hour Ave. Conc.[3] ($\mu g/m^3$) $C_{10}H_8$ | $C_{11}H_{10}$ | $C_{12}H_{10}$ | $C_{13}H_{10}$ | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jul 11 | S01 | 14:20 | B | 28 | 20-30 | NW | 14 | 13 | 6.4 | 2.9 | Moderate tar odour |
| | S02 | 16:20 | B | 28 | 10-30 | NW/N | 13 | 11 | 6.0 | 2.7 | Odour present |
| | S03 | 18:01 | A | 27 | 15-25 | N | 16 | 14 | 6.3 | 2.7 | Tar odour present |
| Jul 12 | S04 | 17:14 | C | 24 | 10-20 | SW | 26 | 12 | 10 | 4.4 | Moderate/strong odour |
| | S05 | 18:48 | C | 22 | 10-15 | SW | 36 | 12 | 12 | 5.0 | Moderate/strong tar odour |
| | S06 | 20:27 | D | 20 | 00-10 | SW | 69 | 23 | 21 | 8.0 | Very strong tar odour |
| | S07 | 20:59 | D | 19 | 00-05 | SW | 95 | 31 | 19 | 6.1 | Strong/very strong tar odour |
| | S08 | 21:29 | D | 19 | 00-05 | SW | 78 | 29 | 25 | 9.2 | Very strong odour |
| | S09 | 22:17 | D | 18 | 00-05 | SW | 108 | 50 | 33 | 10 | Very strong odour |
| | S10 | 22:49 | D | 19 | 00-05 | SW | 69 | 39 | 22 | 7.6 | Very strong odour present |
| Jul 13 | S11 | 19:15 | E | 22 | 05-15 | N | 5.6 | 15 | 2.5 | 1.0 | Moderate "sweet" odour |
| | S12 | 19:49 | E | 22 | 05-15 | N | 5.6 | 26 | 2.5 | 1.0 | Mild odour |
| | S13 | 20:30 | E | 21 | 00-10 | N | 8.3 | 18 | 3.3 | 1.2 | Odour present |
| | S14 | 21:31 | E | 21 | 00-05 | NNW | 31 | 22 | 7.1 | 2.5 | Mild/moderate odour |

(Table 3 continued...)

**Table 3:** Mobile TAGA 3000 PAH Concentrations (1/2 Hour Ave.)

Trenton (Domtar Wood Preservers) Survey 1989

| Date | Sample Number | Start Time | Location[1] | Meteorological Conditions[2] AT | WS | WD | 1/2 Hour Ave. Conc.[3] ($\mu g/m^3$) $C_{10}H_8$ | $C_{11}H_{10}$ | $C_{12}H_{10}$ | $C_{13}H_{10}$ | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jul 13 | S15 | 22:19 | E | 20 | 00-10 | NNE | 9.0 | 23 | 3.6 | 1.3 | Mild/moderate odour |
| | S16 | 23:09 | F | 20 | 00-05 | N | 31 | 13 | 7.1 | 2.4 | Moderate odour |
| Jul 17 | S17 | 12:44 | C | 27 | 00-15 | SW | 51 | 23 | 19 | 8.1 | Moderate/strong odour |
| | S18 | 13:41 | C | 26 | 10-20 | SW | 63 | 28 | 25 | 11 | Moderate/strong odour |
| | S19 | 14:12 | C | 26 | 10-20 | SW | 67 | 27 | 25 | 11 | Moderate/strong odour |
| | S20 | 15:41 | G | 26 | 15-20 | SW | 16 | 47 | 8.9 | 3.3 | Moderate "sweet" odour |
| | S21 | 19:15 | C | 24 | 05-10 | SW | 120 | 44 | 36 | 13 | Strong/very strong odour |
| | S22 | 19:47 | C | 23 | 05-10 | SW | 138* | 50 | 44 | 17 | Strong odour present |
| | S23 | 20:44 | C | 21 | 00-05 | SW | 124 | 42 | 31 | 11 | Moderate/strong odour |
| | S24 | 21:14 | C | 20 | 00-05 | SW | 78 | 26 | 20 | 7.1 | Strong odour |
| Jul 18 | S25 | 16:12 | C | 28 | 10-25 | SW | 58 | 23 | 23 | 10 | Moderate odour |
| | S26 | 16:45 | C | 28 | 10-20 | SW | 58 | 24 | 25 | 11 | Moderate odour |
| | S27 | 19:05 | H | 25 | 05-10 | SW | 96 | 82 | 76* | 25 | Odour present (sweet) |
| | S28 | 19:38 | H | 24 | 00-10 | SW | 136* | 108 | 97* | 32* | Strong odour |

(Table 3 continued...)

**Table 3:** Mobile TAGA 3000 PAH Concentrations (1/2 Hour Ave.)

Trenton (Domtar Wood Preservers) Survey 1989

| Date | Sample Number | Start Time | Location[1] | Meteorological Conditions[2] AT | WS | WD | 1/2 Hour Ave. Conc.[3] ($\mu g/m^3$) $C_{10}H_8$ | $C_{11}H_{10}$ | $C_{12}H_{10}$ | $C_{13}H_{10}$ | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jul 18 | S29 | 20:08 | H | 22 | 05-10 | SW | 189* | 136* | 123* | 38* | Strong odour present |
| Jul 19 | S30 | 13:57 | I | 32 | 00-10 | W/SW | 2.7 | 1.5 | 0.7 | 0.3 | Very mild odour/wind shifts |
| | S31 | 14:53 | J | 31 | 05-15 | WSW | 50 | 34 | 40 | 14 | Moderate odour |
| | S32 | 15:29 | J | 31 | 05-15 | WSW | 67 | 44 | 52 | 20 | Moderate odour |
| | S33 | 16:06 | J | 30 | 05-10 | WSW | 47 | 31 | 33 | 13 | Moderate odour |
| | S34 | 16:38 | J | 30 | 05-10 | WSW | 65 | 44 | 16 | 17 | Moderate odour |
| | S35 | 18:23 | J | 28 | 00-10 | S/SSW | 81 | 51 | 55 | 19 | Moderate/strong odour |
| | S36 | 20:26 | K | 24 | 00-05 | N/NE | 18 | 7.1 | 4.2 | 1.5 | Mild odour |
| | S37 | 20:56 | K | 24 | 00-05 | NE | 17 | 13 | 2.9 | 1.0 | Mild odour |
| Jul 20 | S38 | 16:26 | L | 25 | 10-20 | NE | 51 | 18 | 8.7 | 2.4 | Moderate/strong odour |
| | S39 | 16:57 | L | 25 | 10-15 | NE | 16 | 7.2 | 2.8 | 0.8 | Mild/moderate odour |
| | S40 | 17:55 | L | 25 | 10-20 | NE | 23 | 14 | 5.4 | 1.5 | Moderate odour |

Note: 1. See Map 1 for monitoring locations.

2. Met. conditions at 10 metres: AT=ambient temperature (°C); WS=range of wind speeds (km/hr); WD=predominant wind direction.

3. ± uncertainty of quoted concentrations based on daily calibration factors of PAHs (eg. $C_{10}H_8$ = naphthalene, $C_{11}H_{10}$ = methylnaphthalene, $C_{12}H_{10}$ = biphenyl and $C_{13}H_{10}$ = fluorene) is in the range 6 to 35%. See Appendix A for daily average calibration factors and corresponding variations.

* Values exceed calibration maxima of 130 $\mu g/m^3$ for $C_{10}H_8$, 120 $\mu g/m^3$ for $C_{11}H_{10}$, 60 $\mu g/m^3$ for $C_{12}H_{10}$ and 25 $\mu g/m^3$ for $C_{13}H_{10}$.

**Table 4:** A Comparison of Naphthalene Half-Hour Average Concentrations Between Real-time Measurements (TAGA 3000) and Cartridge Samples (GC/MS), July 19, 1989

| Start Time | Sample # (TAGA) | Concentration ($\mu g/m^3$) TAGA 3000 | GC/MS | % Difference |
|---|---|---|---|---|
| 13:57 | S31[1] | 2.7 ± 6% | 2.2 ± 20% | -19% |
| 14:53 | S32[2] | 50 ± 6% | 59 ± 20% | +18% |
| 15:29 | S33[2] | 67 ± 6% | 83 ± 20% | +24% |
| 16:38 | S35[2] | 65 ± 6% | 62 ± 20% | - 5% |

Note: 1. Sampling conducted at Site I. See Map 1.
2. Sampling conducted at Site J. See Map 1.

## Appendix A

Calibration[1] of PAHs[2]: Naphthalene ($C_{10}H_8$), 2-methylnaphthalene ($C_{11}H_{10}$), biphenyl ($C_{12}H_{10}$) and fluorene ($C_{13}H_{10}$).

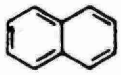
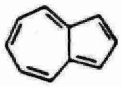
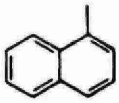
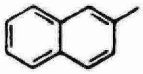
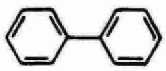
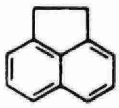
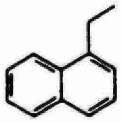
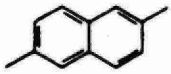
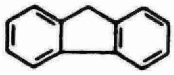
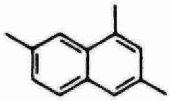
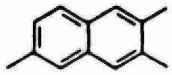
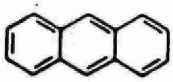
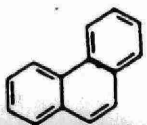
Slopes of Response Curves (ICPS/$\mu gm^{-3}$)

| Date | Time | AT[3] | $C_{10}H_8$ | $C_{11}H_{10}$ | $C_{12}H_{10}$ | $C_{13}H_{10}$ | # Tcals | R2[4] |
|---|---|---|---|---|---|---|---|---|
| Jul 11 | 11:10 | 26 | 951±1%[5] | 717±1% | 512±1% | 478±8% | 3 | 0.9972 |
| | 19:15 | 22 | 1,229±4% | 906±4% | 639±5% | 599±4% | 2 | 0.9978 |
| | | | 1,090±13%[6] | 812±12% | 576±11% | 539±11% | | |
| Jul 12 | 19:43 | 22 | 855±3% | 678±3% | 479±3% | 473±3% | 3 | 0.9987 |
| | 00:20 | 14 | 1,585±4% | 1,319±5% | 936±5% | 973±5% | 2 | 0.9978 |
| | | | 1,220±30% | 999±32% | 708±32% | 723±35% | | |
| Jul 13 | 17:11 | 25 | 1,031±1% | 758±1% | 532±1% | 502±1% | 2 | 0.9979 |
| | 01:00 | 18 | 1,603±5% | 1,149±6% | 788±5% | 685±6% | 3 | 0.9990 |
| | | | 1,317±22% | 954±21% | 660±19% | 594±15% | | |
| Jul 17 | 18:26 | 25 | 1,220±2% | 873±2% | 634±2% | 607±2% | 3 | 0.9969 |
| | 22:45 | 16 | 1,825±5% | 1,424±6% | 1,010±6% | 955±7% | 3 | 0.9969 |
| | | | 1,523±20% | 1,149±24% | 822±23% | 781±22% | | |
| Jul 18 | 15:00 | 28 | 791±2% | 624±3% | 446±3% | 431±2% | 3 | 0.9980 |
| | 21:45 | 20 | 1,134±4% | 885±4% | 605±4% | 575±5% | 3 | 0.9965 |
| | | | 963±18% | 755±17% | 526±15% | 503±14% | | |
| Jul 19 | 12:44 | 32 | 1,436±4% | 1,276±5% | 915±6% | 950±6% | 3 | 0.9990 |
| | 18:00 | 28 | 1,630±2% | 1,429±1% | 1,057±1% | 1,100±2% | 3 | 0.9987 |
| | | | 1,533±6% | 1,353±6% | 986±7% | 1,025±7% | | |
| Jul 20 | 15:30 | 27 | 991±2% | 755±1% | 546±2% | 533±2% | 3 | 0.9977 |
| | 19:10 | 25 | 1,278±3% | 1,029±4% | 738±5% | 710±4% | 3 | 0.9974 |
| | | | 1,135±13% | 892±15% | 642±15% | 622±14% | | |

1. Calibrations were performed upwind of Domtar Wood Preservers Inc.
2. A mixture of naphthalene, 2-methylnaphthalene, biphenyl and fluorene in benzene was used.
3. AT = ambient temperature at time of calibration in °C
4. Average correlation coefficients of linear plots of response (ICPS) vs PAH concentration ($\mu g/m^3$). The lowest value of R2 was 0.9965 and the highest 0.9990. Calibrations were performed in the concentration range 0 to 130 $\mu g/m^3$ for naphthalene and biphenyl, 0 to 120 $\mu g/m^3$ for 2-methylnaphthalene and 0 to 25 $\mu g/m^3$ for fluorene.
5. The standard deviation is based on the number of consecutive calibrations(# Tcals).
6. The variation is based on the daily average responses.

# Appendix B

## List of Polycyclic Aromatic Hydrocarbons (PAHs), Their Structure, Molecular Weight, Melting and Boiling Points

| Structure | IUPAC nomenclature (synonyms) | Molecular weight | Melting point (°C) | Boiling point (°C)$^{760}$ |
|---|---|---|---|---|
|  | Naphthalene<br>Tar Camphor<br>White Tar<br>Moth Flakes | 128 19 | 81 | 218 |
|  | Azulene | 128 19 | 100 | 270 |
|  | 1-Methylnaphthalene<br>α-Methylnaphthalene | 142 20 | -22 | 245 |
|  | 2-Methylnaphthalene<br>β-Methylnaphthalene | 142 20 | 35 | 241 |
|  | Biphenyl<br>Diphenyl<br>Phenylbenzene<br>Bibenzene | 154 21 | 71 | 255 |
|  | Acenaphthene<br>Naphthyleneethylene | 154 21 | 96 | 279 |
|  | 1-Ethylnaphthalene | 156 23 | -14 | 259 |
|  | 2,6-Dimethylnaphthalene | 156 23 | 110 | 262 |
|  | Fluorene<br>2,3-Benzindene<br>Diphenylenemethane | 166 23 | 117 | 294 |
|  | 1,3,7-Trimethylnaphthalene | 170 25 | 14 | 280 |
|  | 2,3,6-Trimethylnaphthalene | 170 25 | 101 | 286 |
|  | Anthracene | 178 24 | 216 | 340 |
|  | Phenanthrene<br>o-Diphenylenethylene | 178 24 | 101 | 338 |

## Appendix C

Plant process description and retort schedules

**Domtar Inc.-Domtar Chemicals Group/Wood Preserving Division**
126 Marmora Street
Trenton, Ontario

### 1. Introduction

The Domtar Chemicals Group/Wood Preserving Division of Domtar Inc. operate a wood preserving plant at Trenton. The plant is located on a 20 hectare site on the east bank of the Trent River within the city limits.

The property was acquired in 1913 by the Canada Creosoting Company Limited and the wood preserving plant was built at that time. In 1942, the site was purchased by Dominion Tar and Chemical Company Limited. In 1965, the corporate name of the company was changed to Domtar Limited, to Domtar Limited-Domtar Limitee in 1969 and subsequently to Domtar Inc.

The Company processes railroad ties, bridge timber, pilings and some lumber utilizing two wood preserving processes in its operation. One process uses 95:5 mixture of light fuel oil and pentachlorophenol to treat utility poles. The second process uses a 50:50 mixture of creosote and bunker C oil to treat railway ties and pilings. The creosote preserving operation accounts for 60 percent of production and the pentachlorophenol perserving operation accounts for 40 percent of production.

### 2. Process Description

a) Wood Conditioning

Unseasoned wood is required to be conditioned in order for it to be suitable for treatment. The Boulton or boiling-under-vacuum process is used to preserve wood at the site.

In the Boulton process, the wood is heated in an oil preservative under vacuum, usually at temperatures of 180° - 220°F. Vapour produced in the treating cylinder is passed through a surface condensing system and the condensate thus formed is routed to

collection tanks. Due to the fact that the vapours either contact the oil coated cylinder or pass through the preservative solution, the condensate is contaminated and requires further treatment. This water makes up the greater portion of the plant's process wastewater.

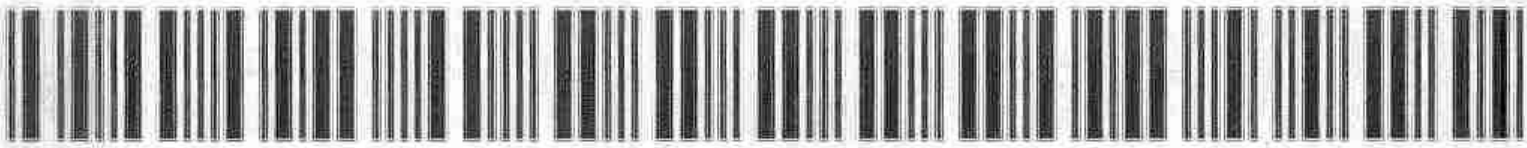
b) Process Equipment

The pressure treating of wood is performed in steel cylinders, capable of sustaining pressures up to 200 psi and vacuum to 24 inches of mercury. These cylinders are fitted with steam coils and external heat exchangers to maintain solution temperature during the processing cycle and are equipped with pipelines to convey preservatives, water, air and vacuum as required. The cylinders are also equipped with instrumentation to measure and record the processing temperature, vacuum and pressure. Vacuum is applied by means of liquid ring vacuum pumps and steam is purchased from the neighbouring Domtar Packaging plant.

The wood to be treated is placed on steel trams on railway tracks placed on a concrete pad. Loaded trams are charged into the treating cylinder. Heat and pressure are applied to the wood in the cylinder for a period of time. After a predetermined time, the preservative is drawn off the bottom of the cylinder and a vacuum is applied from a port at the top. The vacuum is applied to assist with removal of residual superficial preservative from the wood.

**Wood Treatment Operations July 11 - 20, 1989**
Domtar Wood Preservers Inc.

| Charge | Date | Time of Retort Opening | |
|---|---|---|---|
| | | Retort #1 (PCP) | Retort #2 (Creosote) |
| 0832 | July 11 | | 03:42 |
| 0833 | July 11 | 7:00 | |
| 0834 | July 11 | | 18:16 |
| 0835 | July 11 | 15:51 | |
| 0836 | July 11 | 23:40 | |
| 0837 | July 12 | | 08:42 |
| 0838 | July 12 | 08:30 | |
| 0839 | July 12 | | 22:23 |
| 0840 | July 12 | 16:50 | |
| 0841 | July 13 | 01:18 | |
| 0842 | July 13 | | 14:00 |
| 0843 | July 13 | 09:30 | |
| 0844 | July 13 | 23:24 | |
| 0845 | July 14 | | 00:36 |
| 0846 | July 14 | 11:48 | |
| 0847 | July 14 | | 09:06 |
| 0848 | July 14 | | 19:12 |
| 0849 | July 14 | 19:48 | |
| 0850 | July 17 | 12:12 | |
| 0851 | July 17 | | 09:30 |
| 0852 | July 17 | | 18:00 |
| 0853 | July 18 | 01:24 | |
| 0854 | July 18 | | 03:30 |
| 0855 | July 18 | 10:06 | |
| 0856 | July 18 | | 18:13 |
| 0857 | July 18 | 18:53 | |
| 0858 | July 19 | | 03:54 |
| 0859 | July 19 | 07:42 | |
| 0860 | July 19 | | 13:31 |
| 0861 | July 19 | 21:04 | |
| 0862 | July 20 | | 07:54 |
| 0863 | July 20 | 09:00 | |
| 0864 | July 20 | | 16:40 |
| 0865 | July 20 | 17:12 | |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